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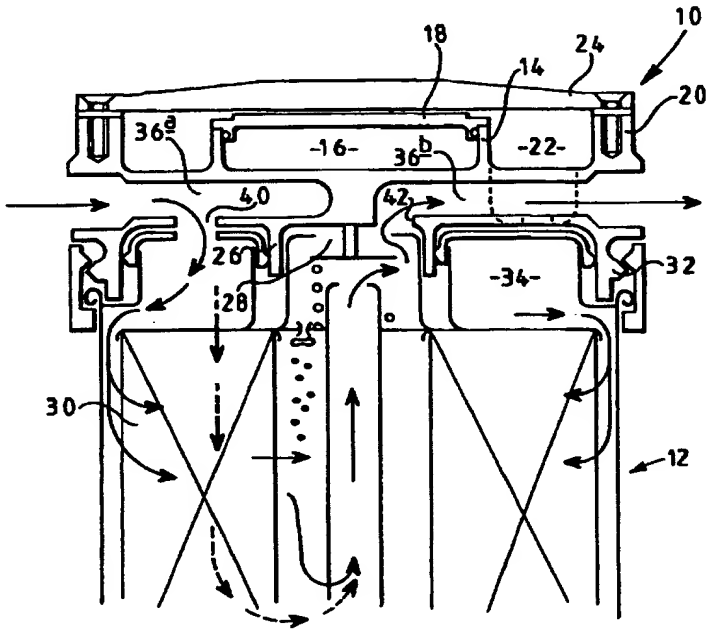
(54) Abstract Title
Filter heads with variable flow paths

(57) A filter head comprises a lower chamber 28 arranged to communicate with a central part of an associated filter 30, an upper chamber 22 and a plurality of ports 40, 42 communicating with a plurality of drillings 36a 36b located between the upper and lower chambers 22, 28. The arrangement of the drillings 36a 36b allows a variety of flow paths to be defined, dependent on where the ports 40, 42 are bored. The filter head may also comprise a valve, controlling flow to or from the upper chamber 22.

FIG 1



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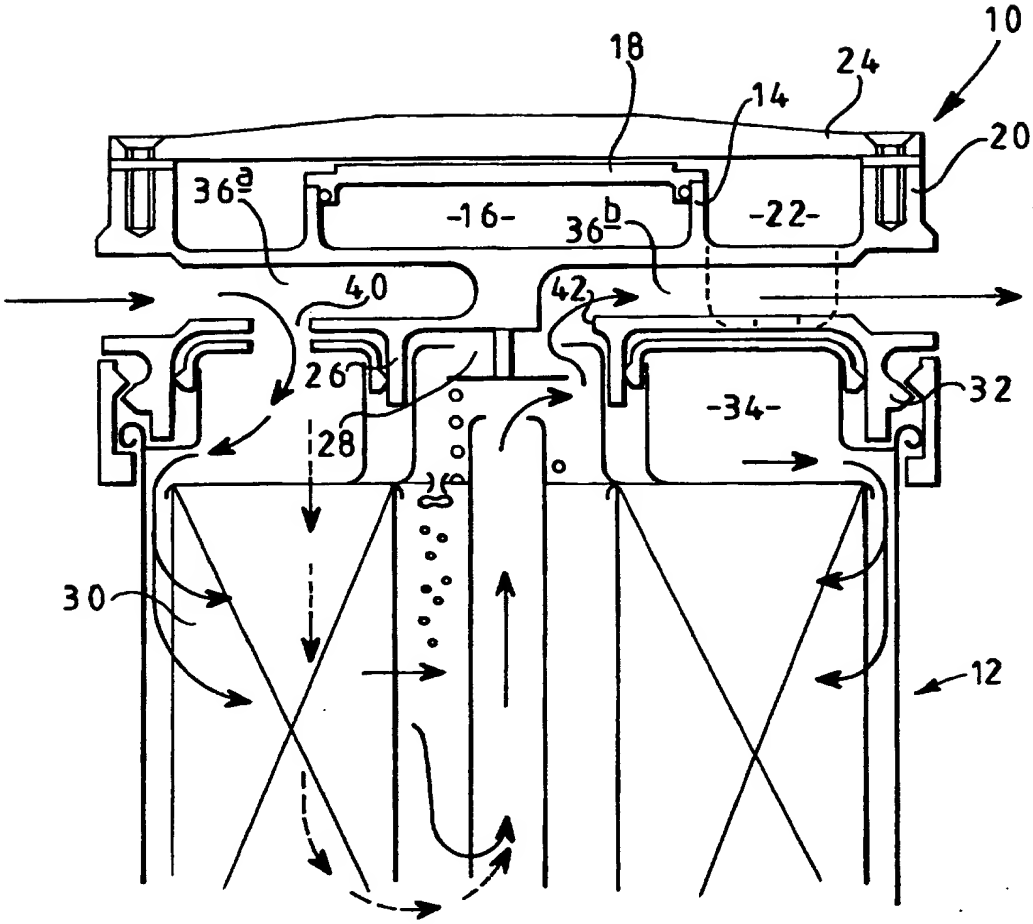
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995

FIG 1



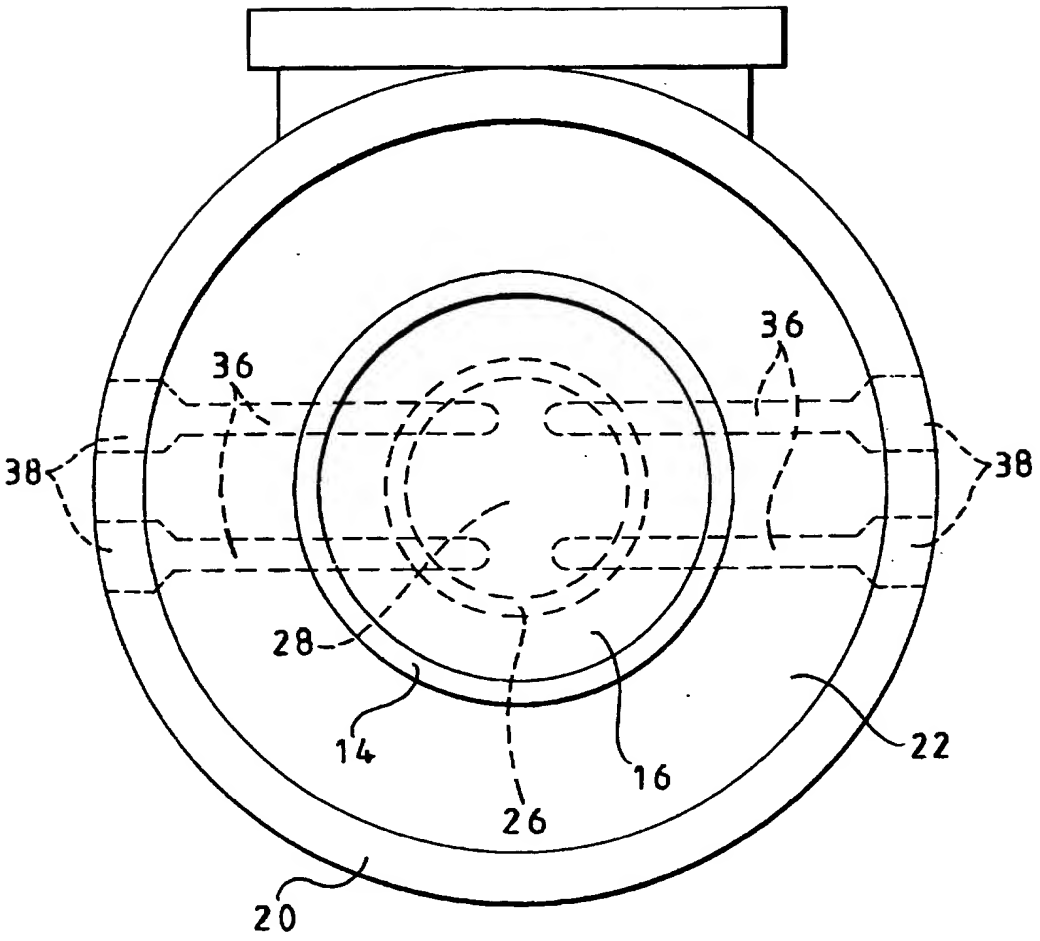
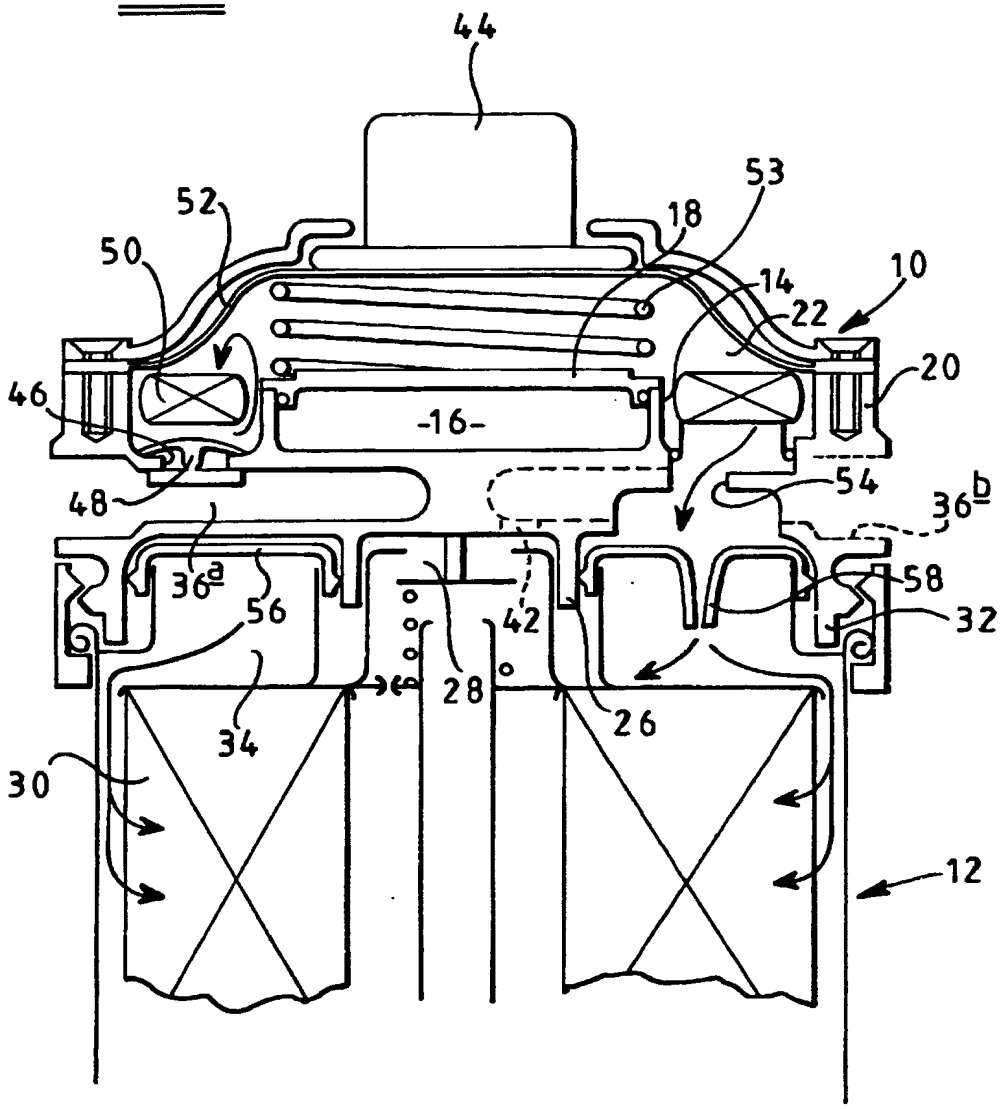


FIG 2

FIG 3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36a
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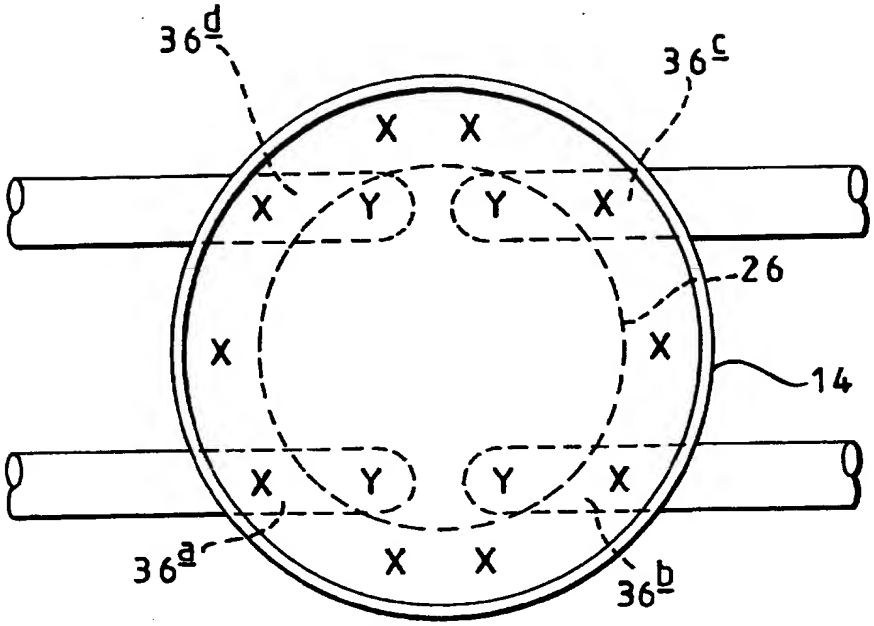


FIG 4a

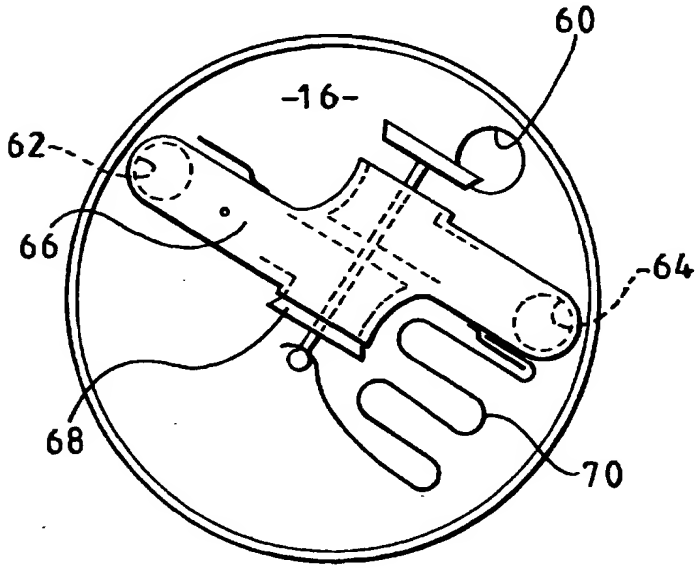


FIG 4b

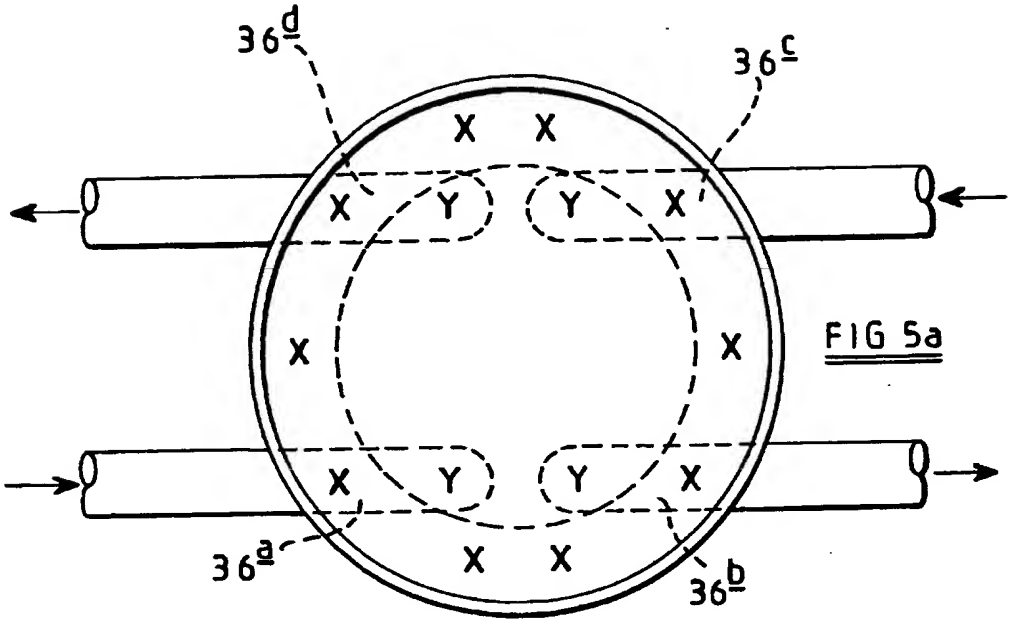


FIG 5a

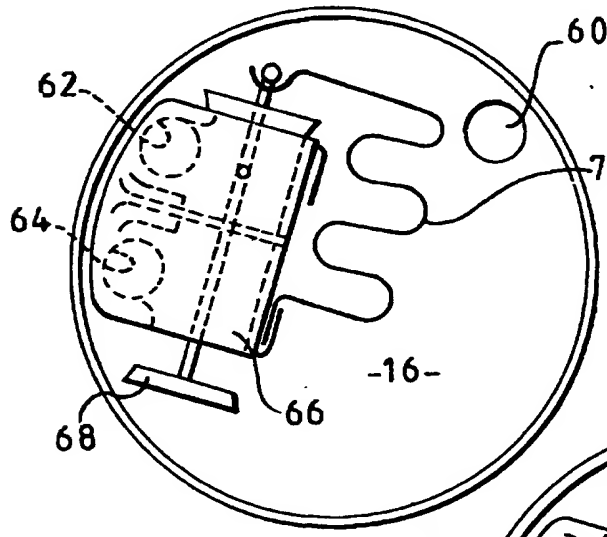


FIG 5b

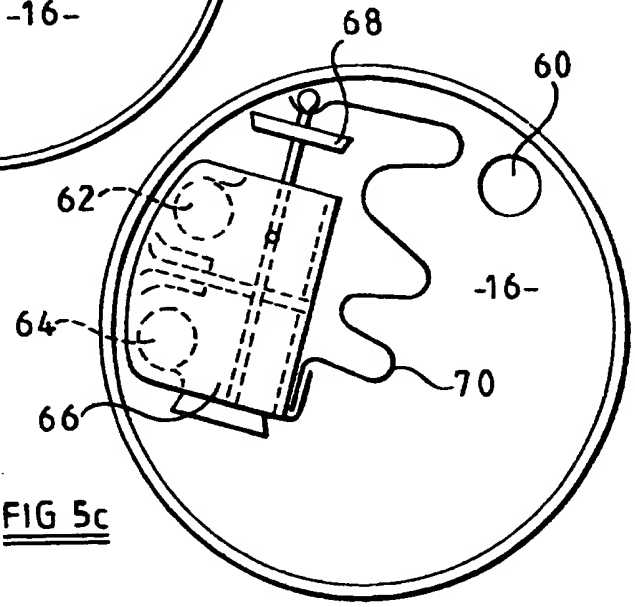


FIG 5c

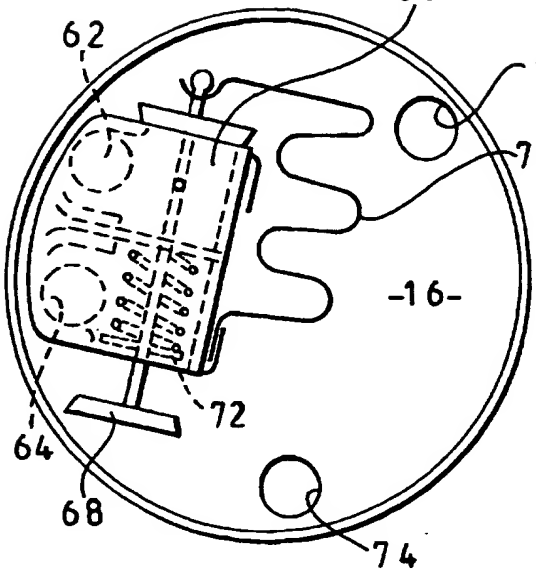


FIG 6

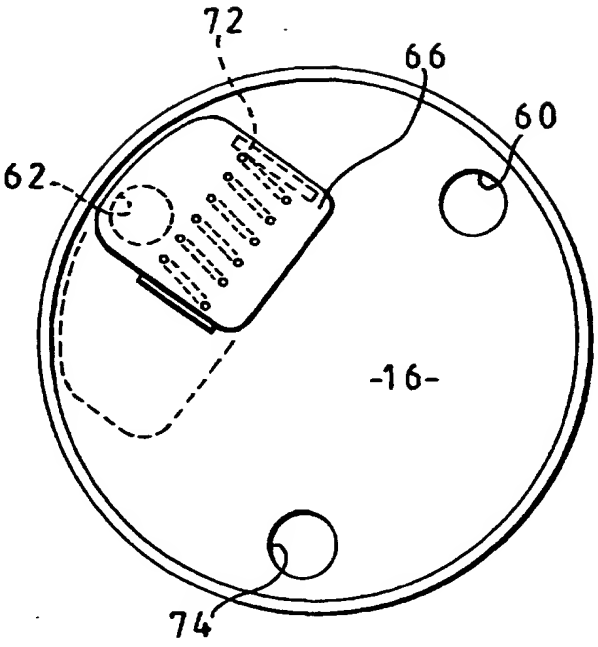


FIG 7

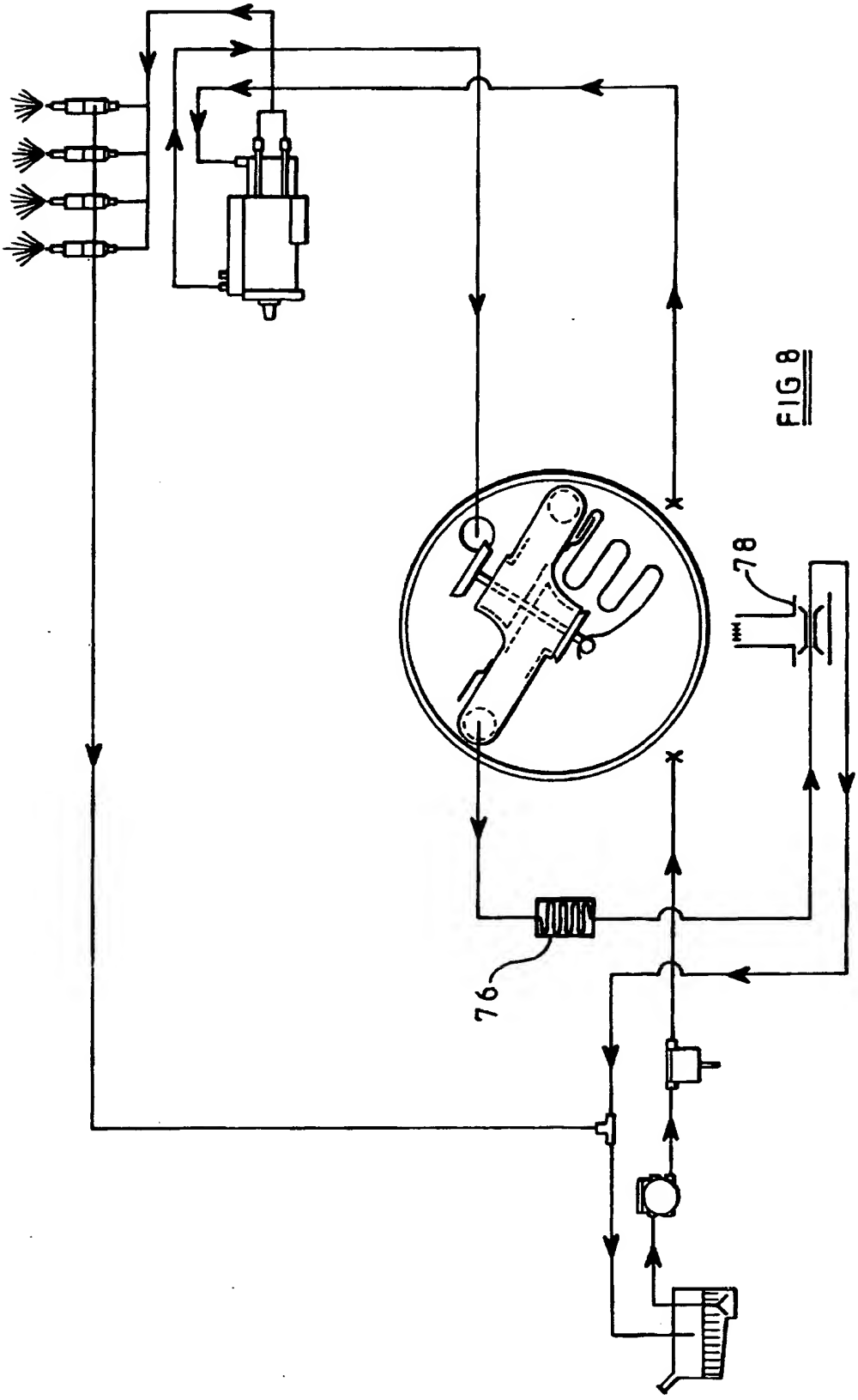
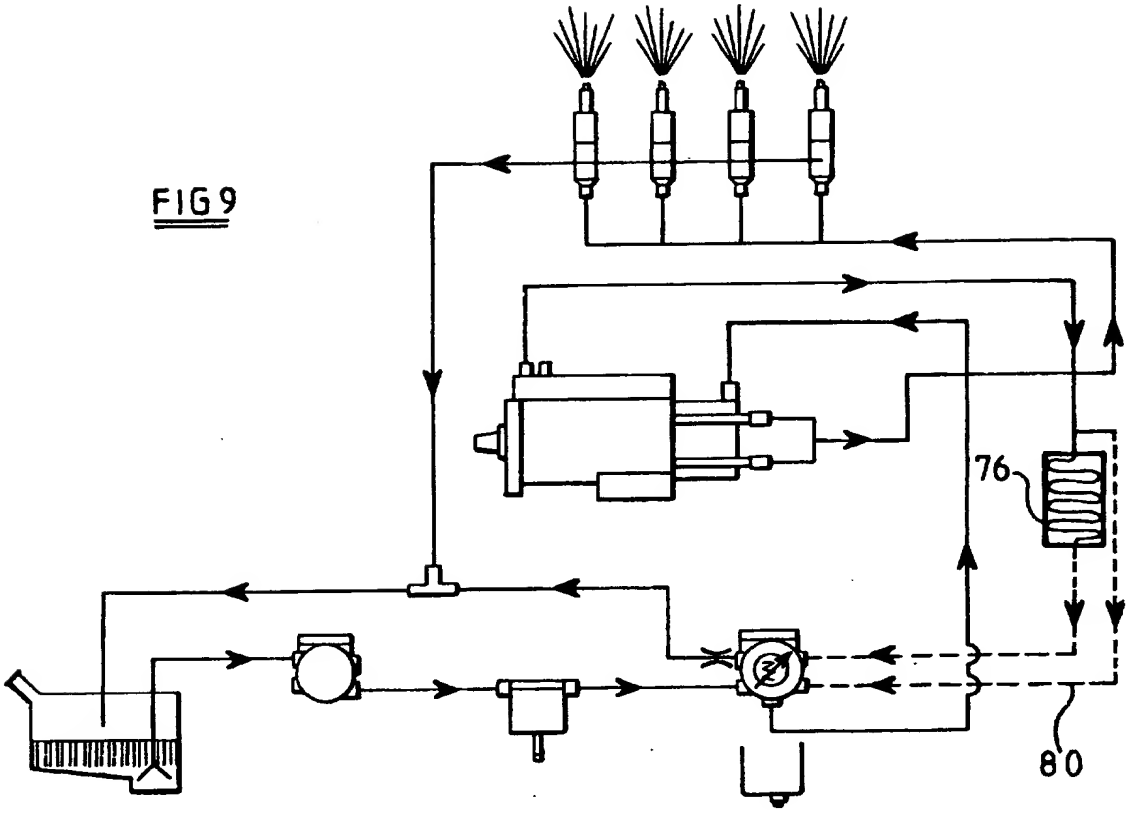


FIG 8

FIG 9



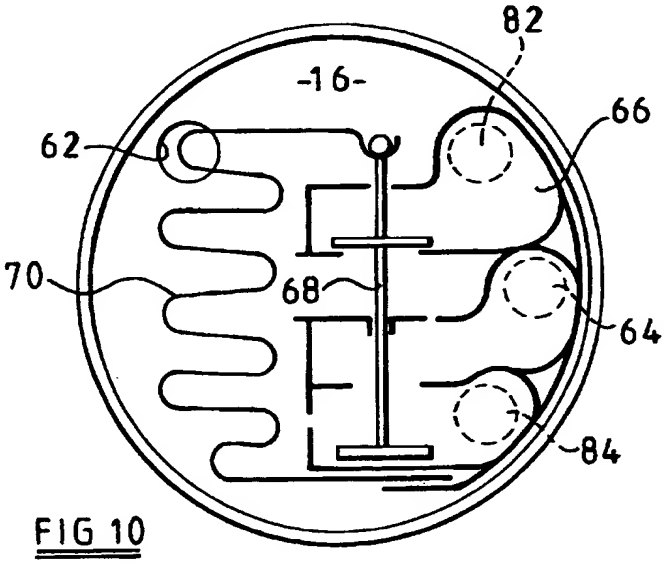


FIG 10

FILTER HEAD

This invention relates to a filter head for use in a fuel system for a compression ignition internal combustion engine.

It is usual to provide a filter arrangement in an engine fuel system in order to remove contaminants from a flow of fuel towards a high pressure pump as such contaminants may damage the pump or result in inefficient operation of the pump or fuel injectors, for example as a result of the contaminants blocking small openings in the injectors. The filter element of such a filter arrangement has a relatively short useful working life as the contaminants gradually choke the filter element. In order to permit relatively simple replacement of the filter element, it is known to locate the filter element within a filter housing which is securable to a filter head, the filter head including ports connected to the remainder of the fuel system.

An object of the invention is to provide a filter head having a number of ports, a range of different flow paths being possible through the filter head to permit the head to be used in a range of applications.

According to the present invention there is provided a filter head comprising a lower chamber arranged to communicate, in use, with a central part of an associated filter, an upper chamber located above the lower chamber, and a plurality of ports communicating with drillings located between the upper and lower chambers.

It will be appreciated that by machining appropriate bores in the filter head, any of the ports and the associated drillings can be made to

communicate with the lower chamber. Likewise, any of the ports can be made to communicate with the upper chamber.

The filter head conveniently further comprises a valve module located within the upper chamber, the valve module containing a valve controlling fuel flow to or from the upper chamber.

The valve may take the form of a temperature sensitive valve, or may alternatively or additionally take the form of a pressure relief or non-return valve.

The invention will further be described, by way of example, with reference to the accompanying drawings in which like numerals denote like parts and in which:

Figure 1 is a diagrammatic sectional view of part of a filter arrangement including a filter head in accordance with an embodiment of the invention;

Figure 2 is a diagrammatic plan view of the embodiment of Figure 1;

Figure 3 is a view similar to Figure 1 of a modification to the filter arrangement;

Figures 4a and 4b illustrate, diagrammatically, a valve module suitable for use in the filter head;

Figures 5a, 5b and 5c illustrate an alternative valve module;

Figures 6 and 7 illustrate further valve modules;

Figure 8 illustrates a fuel system using the filter head and valve module of Figures 4a and 4b;

Figure 9 illustrates an alternative fuel system; and

Figure 10 illustrates a valve module suitable for use in the fuel system of Figure 9.

Figures 1 and 2 illustrate a filter arrangement which comprises a filter head 10 to which is secured a filter housing 12. The filter housing 12 is conveniently secured to the filter head using a bayonet-type connection, but it will be appreciated that the housing 12 could be secured to the head 10 using an alternative technique if desired. The filter head 10 is of generally circular form, the upper surface of the filter head 10 including an inner, upstanding annular wall 14 defining an upper chamber 16 which, as illustrated in Figure 1, is closed by a cap 18. The upper surface of the filter head 10 is further provided with an outer, upstanding annular wall 20 which defines, with the inner annular wall 14, an annular chamber 22, a cap 24 being secured to the outer wall 20 to close the annular chamber 22.

The lower surface of the filter head 10 is provided with an inner annular wall 26 which defines a lower chamber 28 coaxial with the upper chamber 16 which, in use, communicates with an inner or central chamber defined by the filter element 30 housed within the filter housing 12. The filter head 10 further includes an outer, downwardly extending annular wall 32 to which the filter housing 12 is secured and defining,

with the inner annular wall 26, an annular chamber 34. Depending upon the nature of the filter element 30, the annular chamber 34 communicates with the upper and/or outer surface of the filter element 30.

The filter head 10 is provided with four drillings 36 which are located between the upper and lower chambers 16, 28 and which communicate with respective connection ports 38.

In the arrangement illustrated in Figure 1, the lower surface of the filter head 10 has been machined to provide a bore 40 providing a flow path between one of the drillings 36a and the annular chamber 34, and a second bore 42 has been provided whereby a second one of the drillings 36 communicates with the lower chamber 28. In use, the port associated with the drilling 36a is connected to a source of fuel, and the port associated with the drillings 36b is connected to an appropriate high pressure fuel pump. Fuel is supplied to the drilling 36a by an appropriate low pressure fuel pump, the fuel flowing through the bore 40 to the annular chamber 34, and from the annular chamber 34 through the filter medium 30 to the central chamber defined by the filter medium 30 and to the lower chamber 28. Fuel from the lower chamber 28 flows through the bore 42 to the drilling 36b and from there towards the high pressure fuel pump. The filter element 30 is of the type in which fuel flows in a generally radially inward direction towards the central chamber, but it will be appreciated that a filter element of the type in which fuel is filtered whilst flowing in a downward direction, returning through the central chamber (as denoted by the dashed arrows in Figure 1) could be used.

It will be appreciated that by machining the bores 40, 42 in appropriate positions in the lower surface of the filter head 10, any of the drillings 36 can be made to communicate with the annular chamber 34 and the lower chamber 28. If desired, bores may be provided whereby any of the drillings 36 not used to carrying fuel can be used to permit the venting of air from the filter head.

The arrangement illustrated in Figure 3 differs from that of Figure 1 in that a hand primer arrangement 44 is provided. The bore 40 is omitted, and instead a bore 46 is provided in the upper surface of the filter head 10 to provide a flow path between the drilling 36a and the annular chamber 22. A valve element 48 is mounted in the bore 46 and orientated to permit fuel to flow from the drilling 36a towards the annular chamber 22, but to substantially prevent fuel returning from the annular chamber 22 to the drilling 36a. A heater coil 50 is located within the annular chamber 22 to permit heating of the fuel prior to the fuel flowing to the filter element 30. It will be appreciated that the heater coil could be replaced by any other appropriate heater device, or omitted if desired. A membrane 52 divides the chamber 22 into two regions, and the hand primer arrangement 44 is arranged to move the membrane 52 in order to change the volume of the part of the chamber 22 to which fuel is able to flow. A return spring 54 is located to move the membrane 52 towards the position illustrated in Figure 3. A bore 54 is provided in the filter head 10 to permit fuel from the annular chamber 22 to flow to the annular chamber 34, and an annular seal 56 provided on the filter housing 12 is shaped to define a duck bill valve arrangement 58 to substantially prevent fuel from returning from the chamber 34 to the chamber 22. It will be appreciated that the duckbill valve arrangement 58 could, if desired, be omitted and instead an element

similar to the valve element 48 located in the bore 54 to allow fuel to flow towards the filter.

In use, in order to prime the filter, the hand primer arrangement 44 is depressed to pump fuel from the chamber 22 to the annular chamber 34 and through the filter medium 30 to the lower chamber 28. Release of the hand primer arrangement 44 results in the membrane 52 returning to the position illustrated under the action of the spring 53, such movement of the membrane 52 drawing fuel through the valve element 48 to recharge the annular chamber 22.

As with the embodiment illustrated in Figure 1, it will be appreciated that the location of the bores 42, 46 can be selected to permit any one of the drillings 36 to communicate with the annular chamber 22, and to permit any of the drillings 36 to communicate with the lower chamber 28.

In a modification to the arrangement illustrated in Figure 3, a low pressure feed pump may be mounted upon the filter arrangement.

The description hereinbefore has only been concerned with the flow of fuel through the filter arrangement from the fuel reservoir towards the high pressure fuel pump. In practice, it is common for fuel to be returned from the high pressure fuel pump to the filter arrangement. Upon initial start up of the engine, the fuel is often at relatively low temperature, and contains waxy particles which may result in temporary clogging of the filter element 30. In order to reduce the effect of such waxy particles or in order to achieve a rapid warm up even when wax precipitation is not a problem, the fuel returned from the high pressure

pump which is at relatively high temperature as a result of the compression of the fuel by the high pressure fuel pump may be returned to the flow of fuel on the dirty side of the filter element 30 thus increasing the temperature of fuel being filtered and reducing the quantity of waxy particles contained in the flow of fuel. The diameters of the bores through which the fuel must flow are chosen to control the rate at which such hot fuel is returned to the dirty side of the filter element 30. However, greater control may be achieved using appropriate valves.

In the arrangement illustrated in Figures 4a and 4b fuel from a fuel reservoir is supplied to the drilling 36a, the drilling 36b communicating with the clean side of the filter element 30 and being used to supply fuel to the high pressure fuel pump. Fuel returning from the high pressure fuel pump is returned through a drilling 36c, and as illustrated in Figure 4b, a bore 60 is provided in the upper surface of the filter head 10 to provide a flow path between the drilling 36c and the upper chamber 16. A bore 62 is provided in the upper surface of the filter head 10 to provide a flow path between the upper chamber 16 and a drilling 36d through which fuel is returned to the fuel reservoir. A further bore 64 is provided in the filter head to provide a flow path between the upper chamber 16 and the annular chamber 34.

A plastics moulded valve module 66 is located in a push fit manner within the upper chamber 16, the valve module 66 including a valve element 68 which is engageable with a first seating to control fuel flow from the upper chamber 16 through the bore 64 to the annular chamber 34 or with a second seating to control communication between the upper chamber 16 and the fuel reservoir through the bore 62 and drilling

36d. The valve member 68 is moveable under the influence of a temperature sensitive member in the form of a bimetallic member 70 so that, when the engine is started and the fuel temperature is relatively low, the valve member 68 occupies the position shown, thus relatively hot fuel from the fuel pump is returned to the dirty side of the filter element. As the fuel temperature increases, the bimetallic member 70 moves the valve member 68 away from the position illustrated thus restricting the flow of fuel towards the dirty side of the filter medium 30 and increasing the rate at which fuel can flow from the upper chamber 16 towards the fuel reservoir. It will be appreciated that other types of temperature sensitive member may be used, for example a shape-memory element.

The arrangement illustrated in Figures 5a, 5b and 5c is similar to that of Figures 4a and 4b but differs in that the bore 64 is provided adjacent the bore 62. Operation of the valve module 66 is as described with reference to Figure 4b, Figure 5b illustrating the valve element 68 where the fuel temperature is relatively low, and Figure 5c illustrating the valve element 68 in the position occupied when the fuel temperature is relatively high.

The arrangement illustrated in Figure 6 is similar to that of Figures 5b and 5c but includes a separate pressure relief valve located in the flow path between the bore 60 and the bore 64 so that, when the engine is relatively cold, the pressure relief valve 72 acts to pressurize the fuel within the chamber 16 to a predetermined level, opening when the pressure exceeds that level to permit fuel to flow to the dirty side of the filter medium 30. Such pressurization of the fuel within the upper chamber 16 is advantageous where the fuel system includes a

thermostart arrangement which is supplied with fuel via a bore 74 provided in the filter head. It will be appreciated that, depending upon the rate of the spring used in the pressure relief valve, the valve may act simply as a non-return valve without significantly increasing the fuel pressure within the upper chamber, if desired.

In the arrangement of Figure 7, the temperature sensitive valve arrangement is omitted, and instead the valve module 66 contains a pressure relief valve 72 acting only to maintain the fuel pressure within the upper chamber 16 at an appropriately high pressure to permit operation of the thermostart arrangement. In this arrangement, as the temperature sensitive valve arrangement is omitted and fuel is not returned to the dirty side of the filter medium 30, the pressure relief valve 72 is located in the fuel flow path between the upper chamber 16 and the fuel reservoir.

Figure 8 illustrates a fuel system incorporating a filter head housing a valve module 66 of the type illustrated in Figure 4b. Fuel returning from the fuel pump to the fuel reservoir is passed through a heat exchanger 76 and a restriction 78 which limits the rate at which fuel is returned to the fuel reservoir. The arrangement of Figure 9 is similar to that of Figure 8 but the heat exchanger 76 is located between the high pressure fuel pump and the filter arrangement, a bypass passage 80 permitting hot fuel to return to the filter arrangement bypassing the heat exchanger 76 upon initial start up of the engine. In this arrangement, a valve module 66 of the type illustrated in Figure 10 is located in the upper chamber 16 of the filter head 10, the valve module 66 controlling the proportion of fuel flowing through the heat exchanger 76 and the proportion bypassing the

heat exchanger 76 and returning directly to the filter head 10 to be returned to the dirty side of the filter element.

In the valve module 66 illustrated in Figure 10, fuel from the heat exchanger 76 enters the valve module 66 through a bore 82, the valve member 68 controlling whether fuel is permitted to flow from the bore 82 towards the bore 62 and low pressure fuel reservoir. Fuel from the bypass passage 80 enters the valve module 66 through a bore 84, the valve element 68 controlling whether fuel from the bore 84 can flow towards the bore 84 which communicates with the dirty side of the filter medium. The position of the valve member 68 is determined using a bimetallic member 70 as described hereinbefore.

In the position illustrated in Figure 10, the fuel temperature is relatively low and the valve element 68 is positioned to permit fuel to return via the bypass passage 80 to the dirty side of the filter medium 30, the valve element 68 substantially preventing return fuel from flowing through the heat exchanger 76 and filter head 10 to the low pressure fuel reservoir. As the fuel temperature rises, the valve element 68 moves to restrict the rate at which fuel is permitted to flow to the dirty side of the filter medium, and to increase the rate at which fuel is permitted to flow through the heat exchanger 76.

In all of the embodiments described hereinbefore, the flow paths through the temperature sensitive valves of the valve modules 66 are arranged so that the effective area available for fuel flow is either constant or changes progressively as the valve element moves and the valve does not form a restriction to return fuel flow from the high pressure pump greater than occurs through normal porting arrangements as arrangements which

result in the flow of return fuel being restricted may cause incorrect operation of the fuel pump and may cause the associated engine to emit unacceptably high levels of smoke emissions.

It will be appreciated that a number of modifications to the described arrangements may be made. For example, additional ports may be provided if desired. Further, connections may be provided whereby a pressure sensor can be located upon the filter to monitor, for example, the pressure drop across the filter element. It will also be appreciated that the filter housing and head need not be of generally circular form but could be of any other desired shape, for example of generally square cross-section.

In the embodiments described hereinbefore, fuel flows through the filter element towards the central chamber thereof. It will be appreciated, however, that the invention is also applicable to arrangements in which fuel flows in the reverse direction.

Conveniently, the valve modules are provided with vent openings whereby air can be purged from the associated fuel system continuously, the purging of air being independent of the operation of the valve modules.

CLAIMS

1. A filter head comprising a lower chamber arranged to communicate, in use, with a central part of an associated filter, an upper chamber located above the lower chamber, and a plurality of ports communicating with drillings located between the upper and lower chambers.

2. A filter head as claimed in Claim 1, further comprising a valve module located within the upper chamber, the valve module containing a valve controlling fuel flow to or from the upper chamber.

3. A filter head as claimed in Claim 2, wherein the valve takes the form of a temperature sensitive valve, a pressure relief or a non-return valve.

4. A filter head substantially as hereinbefore described with reference to any one of the accompanying drawings.

The Patent Office

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INVESTOR IN PEOPLE

Application No: GB 9800652.1 **Examiner:** Steve Wintersgill
Claims searched: 1 to 4 **Date of search:** 12 April 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): B1D (DNFB, DNRE)

Int Cl (Ed.6): B01D 27/08, 35/30

Other: Online: WPI, PAJ, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0,804,957 A2	(LUCAS INDUSTRIES) see whole document.	1 to 4.
X	US 4,515,690	(NISSAN) see whole document, especially Figure 1.	1 to 4.

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.